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Report of the Eclipse Committee of the Royal Astronomical Society, 1889 October 3. Drawn up by H. H. Turner, Secretary to the Committee.

The preparations which have been made since the last meeting of the Committee for observing the Total Solar Eclipse of 1889, December 21–22, are summarised in the following report:—

1. Application was made by the Secretary of the Royal Astronomical Society to the Government Grant Committee of the Royal Society for a sum of 400*l.* for the observation of this eclipse. This application was granted. A sum of 120*l.* has since been paid to Mr. A. A. Common for the mounting of two silver-on-glass mirrors of 20-inch aperture and 45-inch focus, to be used on these expeditions. The mountings are thus the property of the Royal Society by the terms of their grant; and to complete the instruments Mr. Common will present the mirrors to that Society, so that by an expenditure of 120*l.* alone two first-class instruments, of whose excellence more will be said hereafter, will be acquired for eclipse and other work.

Sums of 100*l.* and 120*l.* have also been paid to the observers, the Rev. S. J. Perry and Mr. A. Taylor respectively, for their expenses on the expedition. Mr. Taylor will necessarily make a longer stay at his station, and his journey will be more expensive. The remaining 60*l.* is still in the bank, and will be available for contingencies.

2. On application by the Secretary of this Committee, Messrs. Elder, Dempster & Co., the proprietors of the line of steamers by which Mr. Taylor reaches Loanda, have generously consented to convey him at half the usual fare.

A similar application has been made to the Royal Mail Steamship Company, by whose line the Rev. S. J. Perry reaches Barbados; and the directors have similarly consented to convey him and his assistant to the West Indies for 35*l.* each return fare.

3. Application was made by the Secretary of the Society to the Admiralty for assistance at each of the stations, and the Admiralty have given directions that a vessel should be at the

disposal of each of the observers during the eclipse; and moreover that the one should convey the Rev. S. J. Perry from Barbados to a suitable station on the Salut Isles (on which he has finally decided as the best position), and on the return voyage; and similarly the other should convey Mr. Taylor from Loanda to the station which he may select on the coast, and return with him to Loanda after the eclipse.

4. On application by the Secretary of the Society the Foreign Office has obtained facilities from the French and Portuguese Governments respectively for the expeditious landing of the observers at their respective stations.

5. As regards instrumental equipment:—

A. Captain Abney has lent to the expeditions the two lenses of 4-inch aperture and 5-foot focus, which have previously been used in Egypt (1882), Caroline Island (1883), and Grenada (1886), and one of which was taken to Russia (1887) but without result. Each observer will take one of these lenses.

The mountings for these are—

- (1) A portable mounting made by Messrs. Troughton & Simms for Mr. Maunder's use in 1886 (Grenada), and taken to Russia (1887) by Father Perry.
- (2) A photo-heliograph mounting used by Dr. Schuster in 1886 (Grenada), and since used by Captain Abney at South Kensington.

(1) is the property of the Royal Society, and (2) belongs to the Royal Observatory, Greenwich.

B. Mr. Common has constructed two silver-on-glass mirrors of 20-inch aperture and 45-inch focus for photographing the corona. The mountings have been made from his design, and purchased with part of the special grant for this eclipse (see paragraph 1). Each observer will take one of these mirrors.

C. A 4-inch theodolite and some tools, the property of the Royal Society, and used in the eclipse expedition of 1886, and a prismatic compass, belonging to the Royal Observatory, Greenwich, have been lent to Mr. Taylor.

D. Application has been made to the Admiralty for the use of two chronometers, and they have granted the use of Arnold 590 (one day), and M'Cabe 133 (one day).

6. *The objects of the expeditions* are threefold:—

- I. To detect any possible changes in the corona during the two hours and a half that elapse between totality at the respective stations.
- II. To photograph the coronal extension as far as possible.
- III. To determine the photometric intensity of the corona.

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Both the pairs of instruments (lenses and mirrors) are available for I.; the mirrors were specially designed for II.; both pairs of instruments would be available for III., but for simplification of the programme the mirrors will not be used in this connection.

As regards object I., the similarity of the instruments has been secured in each case. The atmospheric and astronomical conditions will be somewhat different at the two stations, but by varying the exposure it is hoped to get virtually similar photographs at the two ends of the line.

As regards II., it is generally known that eye observations have traced coronal or quasi-coronal light to immense distances from the Moon's limb, especially when the atmospheric absorption is small (as at great heights), and when care is taken to render the eye sensitive before totality. But it is doubtful whether this extension has been photographed; and eminent photographers consider that there is evidence for the supposed extension being simply diffused light from the sky, and not corona at all. The failure of exposures of say three minutes to give sensibly greater extension than one minute is adduced by Captain Abney as a reason for believing the evidence to be on the whole against the reality of coronal streamers. But it must be remembered that it is only quite recently that photographic objectives of more than a few inches aperture have been employed in eclipse work; and the failure to impress the photographic plate may be simply an indication of the feebleness of the light. With the view of attempting to settle this question, Mr. Common has constructed two mirrors which far out-distance in light-grasping power anything previously available for such work. The aperture of each is 20 inches, and the focal length is 45 inches, which, with full aperture, would give a ratio of $1 : 2\frac{1}{4}$; but there is an internal diaphragm, aperture 15 inches, placed at $\frac{1}{3}$ the focal length within the focus, which reduces the ratio of effective aperture and focal length to $1 : 3$. The advantages gained by this internal diaphragm as regards definition at some distance from the centre of the field are pointed out by General Tennant in *Monthly Notices*, vol. xlvii. p. 244.

It does not seem likely that more favourable instrumental conditions can well be devised, with modern methods, for photographing a faint object such as the outer corona; and even if the result be negative it will therefore be of some value. The chief point to be attended to in the use of the mirrors is thus to get long-exposure pictures. Short exposures will also be of interest, but the question the mirrors were built to settle is the reality of the coronal extension.

As regards III., Captain Abney read a paper to the Royal Astronomical Society in 1889, March (*Monthly Notices*, vol. xlix. p. 285), suggesting that the plates taken out by the observers should be fitted with standard squares such as he had described to the Photographic Society in 1885, and which have since been

used by American observers in 1886 and 1889, January 1. Captain Abney has kindly consented to make plates for the expeditions, and put on the squares himself. Each plate will then be available for determining the photometric intensity at any point of the corona which appears on it.

7. The following instructions to the observers have been drawn up for approval by the present Committee:—

(a) Packing cases to be reclosed as far as possible, and protected from the weather and damage. Care to be taken not to damage tin cases.

(b) For as many days as possible before the eclipse all the instruments to be arranged as during the eclipse, and complete rehearsals of all the operations intended to be made during the eclipse to be most rigidly carried out.

(c) A statement of the days on which these rehearsals have been made to be given in the report of the operations. A daily note-book to be kept, and no notes destroyed.

(d) Approximate latitude and longitude of station to be determined and noted, and chronometer rated by any practicable means. (The naval officers will probably do this with sextant.)

(e) Instruments to be focussed, and trial-plates taken, if possible, at least two days before totality. These trial plates to be carefully preserved. For the mirrors the focus should be adjusted, not for the centre of the plate, but for a region about $\frac{3}{4}^\circ$ from centre. This must be determined by star photographs.

(f) Special attention to be given to the rating of the clocks at least three days before eclipse. Notes of rates to be carefully preserved.

(g) A quarter of an hour before totality clocks to be wound, and caps and stops, which had been hitherto used to diminish the amount of light, to be removed if necessary.

(h) The actual method in which time is to be called is left to the observer, but the timekeepers should be thoroughly and carefully drilled, and their counting should be in a loud voice.

(i) There should also be, if possible, three recorders, whose business it will be to enter *independently* the exact second called by the timekeeper when each plate is exposed, and when the exposure is complete. The notes of each to be handed over to the observer without comparison *inter se*, and compared by him as soon as convenient after the eclipse; these records on no account to be altered, but notes of suggested alterations to be made.

(k) There should also be a person specially detailed to give out the plates in order. After exposure they should be immediately placed in the receiving dark chamber.

(l) At the Salut Isles, Father Perry will take complete charge of the mirror, and Mr. Rooney (under his direction) of the lens.

At the African station, Mr. Taylor will take charge of the

lens, and will entrust the mirror to the most capable person available, who shall be under Mr. Taylor's supervision before and after totality, but shall act entirely independently during totality.

(m) The following plates are to be exposed :—

With the Lenses.

| Mr. Rooney. | | | | | Mr. Taylor. | | | | | |
|---|----------------|-----|-----|-----|--------------------|-------------------------------------|--|--|--|--|
| With 1-inch diaphragm 4 secs. ($=\frac{1}{4}$ sec. full) | | | | | ... | 4 secs. ($=\frac{1}{4}$ sec. full) | | | | |
| 8 „ ($=\frac{1}{2}$ sec. full) | | | | | ... | 8 „ ($=\frac{1}{2}$ sec. full) | | | | |
| Full aperture | 1 sec. | ... | ... | ... | ... | 1 sec. | | | | |
| | 5 secs. | ... | ... | ... | ... | 5 secs. | | | | |
| | 15 „ | ... | ... | ... | ... | 15 „ | | | | |
| | 40 „ | ... | ... | ... | ... | 40 „ | | | | |
| | Sum = 93 secs. | | | | ... | 70 „ | | | | |
| Totality = 135 „ | | | | | Sum = 163 secs. | | | | | |
| Two at discretion. | | | | | Totality = 186 „ | | | | | |
| (2 secs. or 5 secs. suggested.) | | | | | One at discretion. | | | | | |

With the Mirrors.

| Father Perry. | | | Mr. Taylor's assistant. | | |
|-----------------------|---|------------------|-------------------------|---|------------------|
| 1 sec. | } | | 1 sec. | } | |
| 5 secs. | | | 5 secs. | | |
| 10 " | | = 76 secs. | 10 " | | = 76 secs. |
| 20 " | | Totality = 135 " | 20 " | | Totality = 186 " |
| 40 " | | | 40 " | | |
| Others at discretion. | | | Others at discretion. | | |

(n) The plates left to discretion at the end of each series should be developed as soon as possible, as experience with trial plates may suggest. If the development is successful, *and these plates are successfully copied*, the other plates should be developed and copied, but on no account is the development of the earlier plates to be commenced until successful copies are made of the discretionary plates.


Such copies are to be deposited with the most trustworthy person available, to be sent home afterwards on application by the observer.

The pictures should not be overdeveloped, certainly not beyond the point when the densest part of the image can just be seen through the back of the plate.

The two or three developers tried by the observers in England to be thoroughly tested by trial plates before the eclipse. The following is suggested by Captain Abney:—

| | | | | | | |
|---|-----|-------------------|-----------------------|-----|-------------------|---------|
| 1. Pyrogallic acid | ... | 2 grains | No. 1 | ... | $\frac{1}{2}$ oz. | |
| Water | ... | $\frac{1}{2}$ oz. | | 2 | ... | 2 drs. |
| 2. Bromide potass | ... | 20 grains | | 3 | ... | 30 min. |
| Water | ... | 1 oz. | | 4 | ... | 2 dr. |
| 3. Ammonia ('880) | ... | 1 part | Add water up to 2 oz. | | | |
| Water | ... | 9 parts | | | | |
| 4. Sulphite of soda, a saturated solution | | | | | | |

(o) Careful attention to be paid to the orientation of the plates with both instruments by taking photographs of the Sun (with pin-hole apertures) with the telescope clamped (*clock not driving*), at intervals of one hundred seconds on the same plate—so

that the images overlap —on the days before and after the eclipse, at the local time at which the eclipse takes place.

(p) The plates available for use with the mirrors, in addition to those exposed during totality, are to be *exposed after totality*, viz. up to three minutes after totality ends at regular intervals, according to the number of plates at disposal. These plates are designed to determine how long the limb of the Moon is visible against the corona. Eye observations may also be made of this phenomenon by competent observers, but not by the photographers themselves.

(q) Any other observations or drawings which the observers may superintend are to be so arranged that there shall be no possible interruption of the photographers during the half hour including totality.

8. The instruments have been examined by the observers, and are now all ready for the expedition. The Rev. S. J. Perry has taken several photographs with the 4-inch lens (and previously with a 6-inch lens), to thoroughly test the driving of the clock. He has visited Ealing twice, and examined the mounting and working of the mirrors with Mr. Common.

Mr. Taylor's instruments are already packed for transport. He has taken several photographs with one of the mirrors: notably of the Earth-shine on the crescent Moon—exposure, 3 minutes (the crescent being burnt out); of the nebulae in the *Pleiades*—exposure, 30 minutes. The definition is good up to half a degree from the centre, and fair beyond that point.

9. This report would be incomplete without an express reference to the generous assistance the expeditions have received from Captain Abney and Mr. Common. The names of these

gentlemen have already been mentioned in several connections; but Mr. Common especially has given a great deal of time and attention to the numerous matters connected with the expeditions; and this kindly assistance will have contributed in no small degree to any success which the expeditions may meet with.

10. The following details as to other stations and observers may be of interest:—

- (1) Mr. G. C. Bruce, the meteorological officer at St. Helena, wrote to the Astronomer-Royal, offering, on behalf of His Excellency the Governor, every assistance to any expedition which might be sent out. He was informed that the central line passed about $2^{\circ} 50'$ N. of St. Helena, and that station was not therefore to be occupied.
- (2) Professor Holden, of the Lick Observatory, wrote informing the Secretary of the Society that two of his assistants were to proceed to some point in South America for observation of the eclipse, and asking for information as to the movements of our observers. He was informed by the Secretary of this Committee of the general plans of operation, as far as they were then developed.
- (3) Mr. J. P. Smith has made inquiries about the voyage to Cayenne, and was referred to the Rev. S. J. Perry.
- (4) Information has been received that Miss E. Brown and Miss Jefferies are proceeding to Trinidad to observe the eclipse.
- (5) From *Nature*, for 1889, Sept. 12, we learn that the Navy Department in Washington is fitting out an expedition to Muxima, in Angola, about one hundred miles in the interior up the Coanza river. The party will be a large one, under the direction of Professor D. P. Todd, and will remain some time at the station.
- (6) Professor Tacchini has applied to the Committee for leave to join the Rev. S. J. Perry in his expedition to the Salut Isles. [October 18. Professor Tacchini has unfortunately been prevented from joining the expedition.]

Areas of Faculæ and Sun-spots, compared with Diurnal Ranges of Magnetic Declination, Horizontal Force, and Vertical Force, as observed at the Royal Observatory, Greenwich, in the Years 1873 to 1888.

(Communicated by the Astronomer Royal.)

The three upper curves of Plate I., representing the areas of faculæ, whole spots, and umbræ respectively, exhibit in a graphical form the results given on pages 106, 107, and 108 of